FIG. 14 *a*.—Female generative apparatus of Belostoma ($\times \frac{2}{1}$), showing the flexure of the ovaries and immature ova in their upper part.

FIG. 15.—Portion of brain and optic nerves of Belostoma, to show the branching at the extremities of the optic nerves.

FIG. 16.—Cross-section of head of Belostoma from above, to show the auditory chambers and parts of the enclosed antennæ.

FIG. 17. Nervous system of Ranatra ($\times \frac{3}{1}$). The branching of the nerves in the abdomen partly diagrammatic.

FIG. 18.—Antennæ of Belostoma.

FIG. 19.—Antennæ of Perthostoma.

FIG. 20.—Antennæ of Ranatra. The last three figures from camera lucida sketches.

FIG. 21.—Cross-section of pumping apparatus, showing how the muscles are attached to the chitinous threads, and how they divide into two sheets as they pass upwards.

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TOPOGRAPHICAL PHENOMENA IN INDIANA.

BY JOHN T. CAMPBELL.

ABOUT fifteen years ago I was engaged in helping to make several surveys in Western Indiana and Eastern Illinois for railroad purposes. In such work one is apt to notice topography sharply. While thus employed I observed that the hills along all the east-west flowing streams on the up or table-lands were steep and abrupt facing northward, and on the opposite side, facing southward, they were gentle slopes. This was true throughout the glacial drift region. As the streams in nearing the Wabash river wore down below the drift, the slopes reversed, and the steepest hills faced the south, but the difference in slope is not nearly so noticeable as the opposite in the drift.

At the time I first observed this peculiarity of slope, I had read no work on geology, and had but a very limited idea of dynamical geology, derived from a meager recollection of a few lectures on the subject, heard several years before. I supposed these phenomena were not only observed and described, but accounted for. In my subsequent reading on the subjects which ought to cover this, I have been not a little surprised to find that these *facts* have not only *not* been accounted for, but not *observed.* After my failure to find it where I expected, I inquired of men eminent for their knowledge of such subjects as should include this, and have found that not one out of nine seemed to have observed or heard of the phenomena, and several even expressed a doubt of the existence of the facts.

During my subsequent readings and inquiries, I have greatly

extended my observations and investigations of the subject, and confidently believe that I am offering something new in what follows for the consideration of the scientist and philosopher.

In the month of May, 1881, I was employed on a railroad survey from Indianapolis, Indiana, to a point on the Ohio river. Nearly all this time was spent in preliminary lines in Brown county, about fifty miles south of Indianapolis, to find a practicable line across the several high ridges running east and west across this county. These ridges, according to Dr. John Collett, State geologist, headed off the glacial drift from this place. Certain it is there is no glacial drift south of the first or most northern ridge, though both east and west of these ridges the drift extends nearly to the Ohio river, and beyond it on the east side of the State. These hills or ridges look like small mountains, but they are only hills, there being no upheavals. The strata can be traced through all the ridges. These hills are composed almost entirely of Waverly sandstone, or knob-stone, as Indiana geologists call it. Valleys have been eroded over 400 feet deep, by small west flowing streams. The stone dissolves easily on exposure to the weather, hence the great amount of erosion by the small streams, much greater than the same water-shed shows in any other part of the State.

In this region the steep hills face the south, though the difference between opposite slopes is not half so great as in the drift regions to the north.

In the glacial drift region, especially on the high or table-land, where the stream valleys are shallow, the east-west flowing streams lay up close against the foot of the hills on the south side, and these hills are often as steep as a precipice, while on the north side (facing southward) they are often not over twenty degrees from a horizontal.

In this region the trees growing on the south-facing hillsides lean down hill much more than do those on the much steeper north-facing hills, or on the steeper east and west facing hills.

In Brown county, before mentioned, I could not discover any difference in the lean of the trees on the hillsides. The soil on these east-west ridges is composed of the decomposed sandstone before mentioned, and is very thin, especially on the hillsides. In this region the streams wash against the north hills (facing southward) noticeably more than the south side (facing northward), the

reverse of what is so plainly seen in the glacial drift region a few miles to the north.

Another fact of much importance, and quite as striking as the slope of the hills, is that in the large creek and the river bottoms the trees lean down stream, regardless of direction; that is to say, they lean in the direction of the flow of the water which deposited the ground on which they stand. In every case I have examined (I think several hundred), wherever the trees lean up the general course of the stream, there is found the trace of an ancient bend of the channel, turning back up itself for a short distance and abandoned on account of a subsequent cut-off. This tendency of the trees to lean down stream (where the flood deposit is six feet or more) is the same in the drift region and south of it where I have observed, and I presume it is in obedience to a law that is general over the world. At the upper end of the bottoms, where the deposit is old, the leaning tendency decreases, and is greatest at the lower end in the most recent deposits.

In this age it is not easy or comfortable to merely accept these facts and ask no questions. This problem-solving age *will* ask, What law is at work that makes all the north-facing hills from, Indianapolis west to the State line steep, and the south-facing gentle, while in Brown and the east part of Monroe counties, the steep hills face southward and the more gentle northward? The same clouds have rained on both localities; the same cold winds have frozen, and the same sun and warm winds have thawed both localities. The weather effects on topography would not change in the short space of ten miles; but we find a change as soon as we pass south of the southern terminus of the drift.

I offer an explanation of these phenomena for consideration and criticism, but wish to say here, that being aware of my limited knowledge on such subjects, I have submitted my facts and views to as many eminent geologists as I could reach, and sought their opinions. All have signified that this feature of the subject is new. Several have strongly denied my deductions; others have doubted the facts, while still others have given an agnostic shake of their heads—"We don't know." None have offered a better explanation, and my diligent search has found nothing to contradict my theory. As I have no scientific reputation to lose, I can afford to be the little elephant that tries the depth and swiftness of the waters.

The explanation I would suggest is, that sedimentary deposits from running water have always a tendency to move or slide in the direction of the flow of the water making the deposit, and this sliding tendency is in proportion to the swiftness of the water.

I assume that if a trench should be cut across the flood plain of a river at right angles to the current that made the deposit, and as deep as the bed of the river, the up-stream side would in no long time assume a slope of low inclination, while the down-stream side would remain steep, and drop down in falls whenever any change should take place.

Big Raccoon creek, a stream 200 feet wide, enters the Wabash river from the east in this (Parke) county, and flows westward across the Wabash bottoms for one and a half miles. The banks are twelve to twenty feet high, and those on the up-stream side (of the Wabash current) are easy slopes which a foot-man can easily descend to the water's edge, while all the way across this bottom, the opposite down-stream, or south side (facing northward), is like a continuous precipice. The trees growing along the north bank stand from the top of the bank well down to the water's edge, lean down hill from ten to forty degrees, while on the south side they stand erect till so far undermined that they fall into the stream. The current persistently beats against the left or south bank all the way across the Wabash bottom, the same as in the upland drift.

In this country the roads are mostly laid on the section lines, causing nearly all of them to run due north, south, east and west. This takes them over ridges and down and up steep hills, requiring deep cuts and heavy fills. These cuts, where they are through the glacial drift deposit, show the same condition as the creek banks before mentioned, the south-facing side of the cut has the gentlest slope. The water flowing down the gutters at each side of the roadway bear most against the south bank (facing north). The north bank (facing southward) shows much the greatest apparent plasticity, or mobility, to quietly slide down like soft putty and reform the gentle slope, while the opposite side drops down in falls like soft sandstone would be expected to do. I have noticed that the little blocks or cubes into which the drift clay separates in time of drought, have a dip southward in the line of their "season cracks," as we may call it. During protracted

rains the water percolates through these cracks, rendering the cubes soft and slimy, and aiding the plastic slide in the direction of the dip of the cube cracks—southward.

In support of the theory I advance—well, call it speculation—I submit the following facts: If a lump of putty, say twenty-five pounds, with a consistency that would maintain its shape, should have a number of small sticks or common matches stuck into it in an erect position, as shown by the dotted line in Fig. 1, these would represent trees growing on a hillside. If one side of this putty should be exposed to the heat of the sun or a fire, its consistency would be reduced and it would slide as shown by the solid line in Fig. 1, and the matches (trees) would lean down hill.

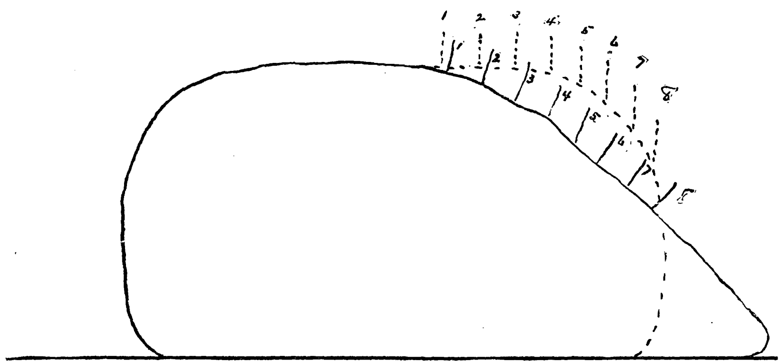

FIG. 1.

The trees always grow vertical unless inclined by some exterior force. On hillsides we find the young trees growing vertically, inclining down hill with age, the oldest inclining most. Without doubt the old trees started in life with good intentions, and tried to grow with the plumb line. When a tree is suddenly inclined as much as forty-five degrees, it will send out saplings from the upper side of its trunk. See tree *h* in Fig. 2, which figure illustrates the different slope of north and south-facing hills in the glacial drift, and the lean of the trees thereon.

Fig. 3 shows the profile of a railroad survey north and south, and crossing east or west streams and ravines in the drift region.

Fig. 4 shows the lean the trees would take at the bends in a river bottom as indicated by the arrows, and the slope of the hills on the north and south side of east and west flowing streams and ravines in the drift region.

As proof that the slope of the hills is not due to the surface

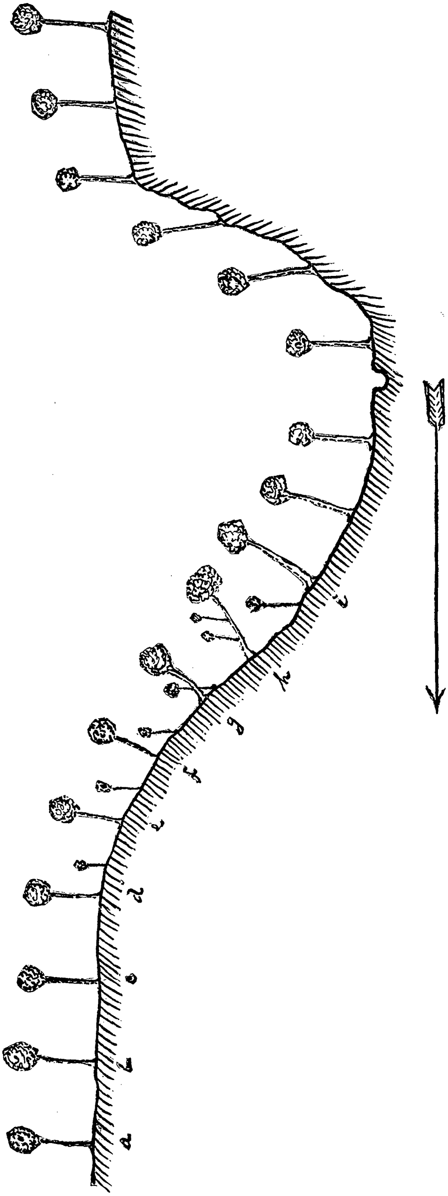

Fig. 2.

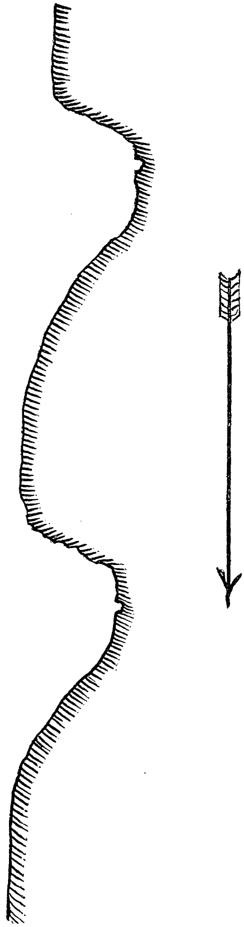

Fig. 3.

washing, or action of frost, we find the roots of the oldest trees about equally exposed at the top, side and foot of the hills ;

whereas, if it was a surface movement, the roots would become bare at the hill top, and covered at the hill's foot, as shown in Fig. 5.

Where this is the case, as it sometimes is, the dotted line represents the surface when the trees began life, and the solid line the surface after rain washings.

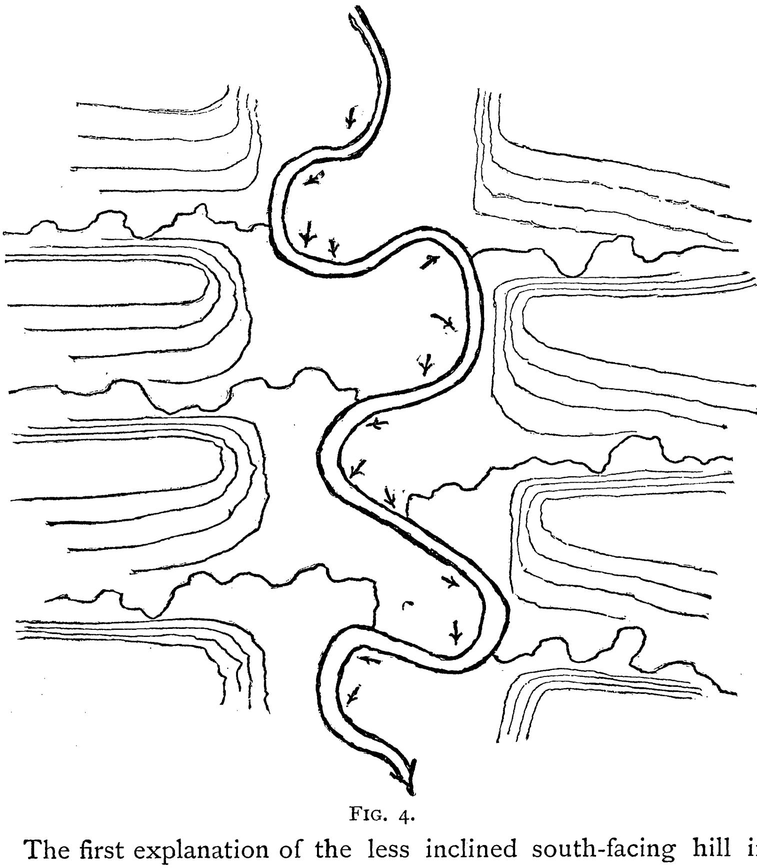

FIG. 4.

The first explanation of the less inclined south-facing hill in the drift is apt to be the lateral push of freezing. That the sun thawing out the south-facing hill so much oftener than the opposite, to be refrozen, gives it the greatest motion. A little reflection will explode this answer. The greatest number of thaws in real winter are due to warm winds and warm rains, when there will be no sunshine. These will affect both hills alike; beside the major part of every thaw comes from beneath and would affect both hills alike. I have seen too much power attributed to the

lateral push of freezing. A careful analysis of its process will show that it can have but little lateral push on level, or even much

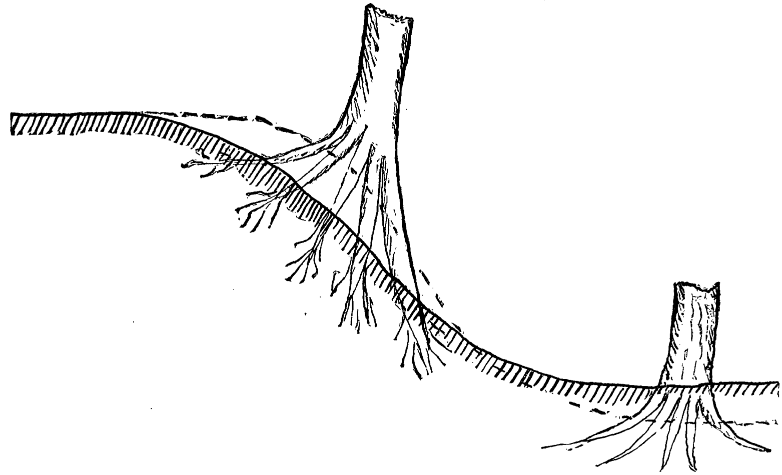

FIG. 5.

on inclined ground. The first freeze is a thin crust on top, not thicker than paper (and about as powerless as paper), which thickens downward as the freeze goes on. The next thickness of freeze below adds nothing to the lateral force of the first, nor does the next, and the next. The only force freezing exerts on the ground is an uplift. There are no cracks in frozen ground as we find in thick ice, which clearly shows that the very doubtful fact of *much* lateral expansion in the under freeze of ice does not apply at all to frozen ground. Cellar and other walls are often pushed in by freezing for the plainest reason. The freeze begins on the face of the wall, extends back through it to the ground, so that the uplift, *a b* in Fig. 6, becomes a side push, *b c*.

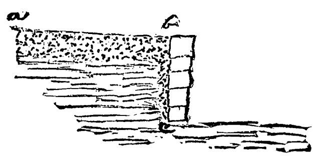

FIG. 6.

This inpush from a freeze never occurs where a cellar is kept warm, but the retain or guard wall of an outside stairway, and other outdoor walls, are often thus pushed. I am fully satisfied that the different slopes of the north and south facing hills is not

due to surface washing or the unequal lateral pressure of freezing.

I have made frequent inquiry of railroad section men, who all

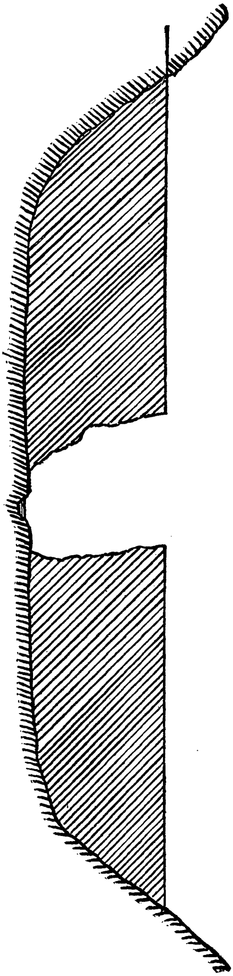

Fig. 8.

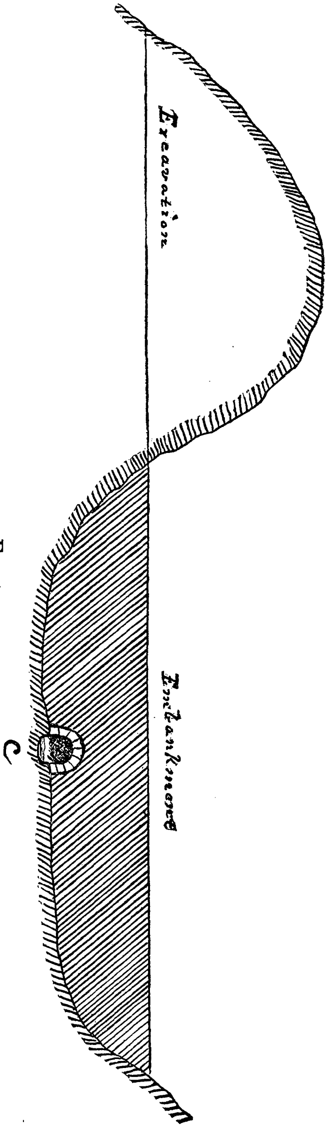

Fig. 7.

tell me that the north side of an east-west railroad embankment washes during rains and slides more than the south side; but the east-west cuts show the same phenomenon as the hills. As they

are constantly repaired the passer-by cannot see the natural effect, but section men say that the ditch on the north side of the cut fills much oftener than the other. Why does a railroad embankment slide one way, while the cut out of which it was taken slides the other? Because they were built by different processes.

Farmers in this country know that when they thresh their grain and stack the straw by carrying it forward from the thresher and throwing it over the forward or outer end of the stack, it will continue for months to slide in that direction, though it would be hard to detect the oblique stratification in the build of the stack.

If a railroad embankment should be built across a valley, with excavations from the adjacent hill carried and poured over the forward end of the embankment till completed, it would be in fact as it appears in Fig. 7, except that the eye could not detect the oblique stratification unless it was due to a change in the color or quality of the earth.

If, after this bank had become well settled, a "washout" should occur, carrying away the culvert, *c* Fig. 7, it would leave two walls standing, as shown in Fig. 8.

The earth is obtained from an excavation at the left and carried to the right, so that the oblique stratification will dip to the right, as shown in Figs. 7 and 8. The bank on the right side of the "washout" would have to break across the line of the oblique stratification, hence it would project, or "overhang," as a precipice, while the opposite side would break more with these strata, would be inclined to slope, as illustrated in Fig. 8.

In the course of a year or so the right bank would break and drop down in falls, and the left would gradually and imperceptibly slide like soft putty, and form a slope as shown in Fig. 9.

Where a bank is built by pouring the earth over the end or side, it will continue to slide in that direction long afterward. I think every engineer of much experience will agree to this. This bank, as shown in Fig. 9, shows the same condition we find in the north and south-facing hills in the drift region, the left side representing the south-facing hill.

Flood plains, or bottoms of streams are deposited in this order: The bars at their up-stream ends are level with low water, and even extend up stream under the water, while at their down-stream end they are elevated as high as the older bottom land, a part of which they ultimately become. The swiftest current is at the

upper end of these bars, consequently only the heaviest pebbles

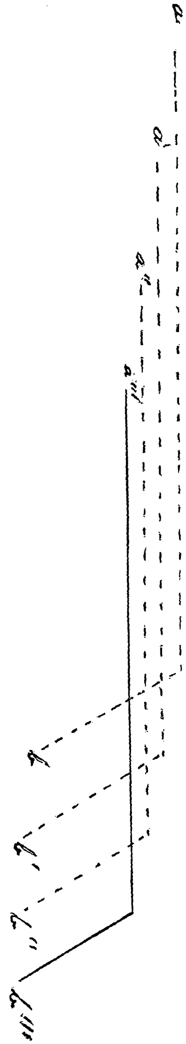

Fig. 10.

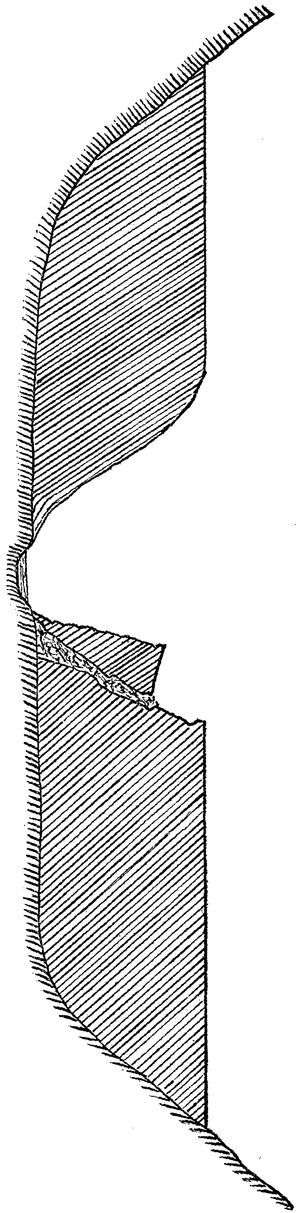

Fig. 9.

are dropped there; the next heaviest being dropped next farther down, and so on to the lower end where the bars always termi-

nate in fine sand, with a pour over the end as shown in the railroad embankment in Figs. 7 and 8, and more definitely in Fig. 10.

In Fig. 10 the dotted line, *a b*, shows the longitudinal section of the bar, as left by the last preceding flood. The line, *a' b'*, shows it as left by the next succeeding flood, and the lines *a'' b''* and *a''' b'''* show the conditions after still later floods. Hence bars and bottoms are always building down stream and being worn away at their up-stream ends. While they are, in *fact*, deposited in an oblique order, it is rarely that the eye can detect it in a longitudinal section of the bottom.

A bottom built in this order would be expected to have a sliding tendency like the straw stacks and railroad banks before mentioned. The fact that the trees which grow thickly over the bar

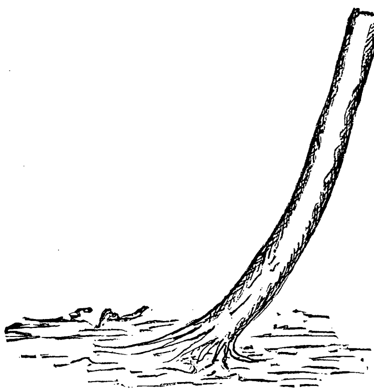

FIG. 11.

over *b b' b''* and *b'''*, at first grow with the plumb line, and begin to lean down stream with age till the grown ones lean from ten to forty degrees, is clear proof to me that the newly deposited bottoms slide like a glacier, obeying the same law of motion, but greatly slower of course. The surface moving faster than the bottom, would incline the trees. If the bottom (flood plain) should slide one foot in fifty years, it would be sufficient to produce the result we see. The trees do not get their inclination from the pressure of the floods. These bottom trees grow rapidly, and in ten years are able to withstand the floods. Beside, the current is always weak at the lower end of the bars. Eddies generally prevail there, otherwise there would be no sediment dropped.

When a growing tree is bent or inclined, it makes an effort to

grow vertical from that time (and point) upward, and at maturity shows the curve and tangent as in Fig. 11.

Nearly all the trees growing on the down-stream end of bottoms, show the lean as in Fig. 11, and some show the bend at the bottom. The young trees, at ten years, show very little inclination as compared with the grown and old ones.

I saw a case in the north-east part of Brown county, before mentioned, on the south side of Jesse Walker's farm (section, township and range forgotten), where a "worm" rail fence had been built on the south boundary line across the bottom of a small stream or brook, the bottom not over 300 feet across. The fence had been built straight, and about eight rails high. The sediment carried from the fields on the adjacent hills during rains, was caught by the grass and so silted up that the bottom rails were submerged. The proprietor kept adding rails to the top as fast as they were submerged at the bottom, so as to keep the necessary height of fence. This continued about fifteen years, when the original eight rails had been entirely covered or submerged, when it was noticed that the fence had been swayed down stream about four to five feet from the original straight line. The sedimentary deposit had certainly moved like a glacier. This coincides with the other facts before stated.

In conclusion, the drift was deposited here by the waters from a receding glacier. The general course of the flow, as indicated by the striations, was about south 15° to 18° west. If my theory is correct, the tendency of the deposit of the drift would be to slide southward. I do not wish to be understood as confidently affirming the correctness of my theory, but that the slope of the hills, the lean of the trees on south-facing hills, taken in connection with the other facts I have cited, strongly suggest my theory as the explanation of the facts. If this theory does not explain the phenomena, what other does? Are there any well-established facts which contradict this theory? If so—what?

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RENUMERATION OF THE SPINAL NERVES AND RECONSTRUCTION OF THE PLEXUSES IN THE HUMAN SUBJECT.

BY DR. ELLIOTT COUES.

THERE being a pair of spinal nerves to each vertebral interspace down to the coccyx, and the pair counted first being